Influencing Software Competencies Across the DoD Acquisition Workforce

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The growing importance of software in delivering military capabilities to the warfighter increases the need for the DoD to identify and support software-specific competencies for the acquisition workforce. To help address this challenge, the Software Acquisition Training and Education Working Group (SATEWG) is defining competencies for each acquisition career field, and reviewing software acquisition curricula against these competencies. This article provides insight into the problems being addressed, the SATEWG's approach to these challenges, and their accomplishments to date.

The complexity and criticality of defense software poses a significant challenge to the acquisition workforce as well as the human capital experts who need to ensure that the workforce has the right competencies to deliver this essential capability to the warfighter. Add to this the task of identifying cross-functional software competencies that are critical for acquisition professionals, and you have the primary challenges facing the SATEWG.

There have been a number of initiatives aimed at improving DoD acquisition outcomes over the years, which have subsequently impacted the acquisition workforce. In the mid-'90s, the DoD adopted a policy encouraging the use of commercial products—rather than those developed to military specifications—in order to take advantage of the innovation available in the commercial marketplace. Commercial standards became preferred over military standards. The government moved toward specifying the expected performance of a system, rather than telling contractors how to build it.

In the '90s era of declining defense budgets, policymakers expected acquisition reform to bring about greater efficiencies in order to pay for defense acquisition. The Federal Acquisition Reform Act (FARA) of 1996 called for greater efficiencies in defense acquisition [1]. The FARA eliminated 15,000 members of the defense acquisition workforce, and called for reductions of 25 percent over the following five years. The focus of the defense acquisition workforce shifted ostensibly from engineering of systems to systems acquisition. The numbers of acquisition personnel dwindled and systems became larger and more complex, creating significant challenges for defense acquisition. These challenges were thrown into the spotlight by Government Accountability Office (GAO) annual audits [2].

The acquisition reform pendulum started swinging the other way when, in 2003, the DoD started an effort to reinvigorate systems engineering in defense acquisition. In 2009, the Secretary of Defense proposed hiring 20,000 new acquisition professionals by the year 2015 [3]. The Weapon Systems Acquisition Reform Act of 2009 established new Directors for Systems Engineering and Developmental Test and Evaluation and called for reports on these parts of the defense acquisition workforce [4]. The challenge, however, continues to be that software engineering is not currently designated by a standalone occupational career code, nor is it managed within the acquisition workforce as its own career field.

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The evolution of acquisition policy has had a significant impact on the acquisition workforce and their ability to manage software acquisition.

Software-Specific Human Capital Challenges

Software is a unique and critical component in the products of DoD, and its reach extends across the acquisition career fields and each of the services at varying levels. The application of modern software technologies, and the use of sound software engineering practices over the acquisition life cycle, are important elements of program execution.

The DoD conducted the first phase of a software industrial base study in 2006 [5], finding that their dependence on larger, more complex software is increasing the risk of not delivering systems on schedule and within budget. Although the study found that the nation's overall number of software developers was adequate for the near-term, it found shortfalls in the number of top-tier software program managers, architects, and domain experts—with perhaps as few as 500 having the skills to develop the DoD's complex, software-intensive systems. Though the software industrial base study did not address the acquisition workforce per se, it is safe to say that these shortfalls in top-tier talent are evident there as well.

It should be noted that subsequent phases of the software industrial base study found shortfalls in the number of adequately trained software developers, which was the primary reason the Office of the Secretary of Defense (OSD) – Acquisition, Technology & Logistics (AT&L) sponsored development of a reference curriculum for graduate study of software engineering [6].

In [7], the National Defense Industrial Association (NDIA) recommends actions including the broadening of expertise "to enhance cross-functional and domain knowledge and skills." It is critical that the DoD begin identifying and embedding the basic software skills needed for each career field. This will reduce the reliance on software experts while increasing the overall abilities of the acquisition workforce.

In 2006, the Navy started the

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Software Process Improvement Initiative (SPII), which identified and examined issues preventing software-intensive projects from meeting schedule, cost, and/or performance goals [8]. A survey conducted as part of the SPII effort found that:

- There is a lack of adequately educated and trained software acquisition professionals and systems engineers.
- There are no established education standards.
- Key staff experience levels are below average.

In [8], the SPII's Human Resources Focus Team recommended identifying the software acquisition training needs tailored to the respective roles and responsibilities for six acquisition career fields: program management, systems and software engineering, acquisition logistics, contracting, legal, and test and evaluation engineering. They also recommended that the DoD use the findings of the report as a baseline to analyze the software competencies and training of the acquisition workforce [8].

In February 2008, the DoD established the SATEWG to develop software competencies for the entire acquisition workforce—not just software experts—starting with program managers and systems engineers [9]. In addition, the SATEWG was chartered to develop and initiate a plan to address the gaps in the existing software acquisition curricula. The SATEWG is comprised of individuals from different organizations with the goal of promoting, across the DoD, collaboration focusing on software and human capital initiatives for the acquisition workforce.

SATEWG Membership

The SATEWG is comprised of representatives from organizations designated by the Under Secretary of Defense (AT&L), and others including the OSD, Army, Navy, Air Force, Defense Acquisition University (DAU), Air Force Institute of Technology, SEI, and Sevatec, Inc.

Each of these organizations plays a role in developing or supporting competencies and curricula, and their active participation has been critical to the success of the group. The diversity of these stakeholders has made for a stronger product. There are two types of SATEWG members: core team members and advisors. This structure encourages leadership involvement and provides flexibility for varying levels of commitment.

Developing a Software Competency Framework

A key challenge for the SATEWG was to identify aspects of software engineering that are truly unique to software and relevant to the broader acquisition workforce. For example, courses often address requirements management and configuration management, but they do not necessarily take into account the volatility of software requirements or the potential for spawning a multitude of slightly different software configurations.

Another challenge for the SATEWG was to identify aspects of software acquisition general enough to be considered critical by the broader acquisition workforce, yet specific enough to support building an interdisciplinary software skillset. This interdisciplinary software skill set reduces dependency on software experts, which in turn becomes more important as the acquisition workforce grows.

The SATEWG created an overarching body of skills called the software competency framework. It is used as the foundation for providing input to the competency models specific to each acquisition career field, and as a source for analyzing existing curricula. During the framework's development, the SATEWG reviewed 234 software competencies and 790 competency elements from the following sources:

- Existing DAU curricula.
- Competency studies and reports conducted by the services (e.g., SPII) [8].
- Industry best practices.
- Existing competency models such as the Software Engineering Body of Knowledge [10]; Systems Planning, Research, Development and Engineering (SPRDE); program management; and IT career fields.

The framework includes the competencies that are both unique to software and cross-functional in nature, so they can be generalized for the various acquisition career fields. Many software-related competencies, although important, weren't deemed by the SATEWG as different enough from the other disciplines to be included in the framework—at least from the perspective of the acquisition workforce. For example, software specifications are certainly different from typical system specifications; however, the process for managing these different types of specifications is quite

similar for the acquisition workforce.

The SATEWG also reviewed the persistent software development and acquisition issues to ensure that the competencies identified are relevant to the pressing needs. This review included the original 1968 NATO efforts defining software engineering [11] as well as the top software issues identified by the NDIA [12]. The most current source turned out to be a systemic analysis of software issues found in DoD reviews of acquisition programs [13].

Components of the Framework

The SATEWG framework consists of the following:

- **Knowledge Areas (4):** High-level descriptions of the overarching skills that make up the software elements of the job.
- **Competencies (29):** Definitions that provide information at a generalized level that allows flexibility for cross-functional comparison. Competencies describe the job requirements and individual capabilities at a broader, more process-oriented level than a single knowledge, skill, or ability. There are multiple competencies under each knowledge area.

The SATEWG decided not to identify the specific performance outcomes for each competency (i.e., the behavior[s] an employee must demonstrate for successful job performance). These expected outcomes will vary from career field to career field. Instead, the SATEWG decided that the performance outcomes should be defined by the groups that manage each career field.

The framework contains software knowledge areas and competencies within each knowledge area (see Table 1).

Applying the Framework

The SATEWG uses the software competency framework to work closely with each career field to help integrate software expertise into their existing competency models.

The SATEWG started working with the SPRDE expert panel to integrate software into their draft SPRDE competency model. The SATEWG identified the key competencies from a software perspective, while the SPRDE expert panel identified the key software competencies from their perspective. Using the competency framework, the SATEWG and SPRDE expert panel tailored the software competencies to the needs of the engineering workforce. The final SPRDE career field model now contains 13 elements that address software; more specifically, 14 of the framework competencies in Table 1 (marked with a "*") were mapped to the final SPRDE model.

The SATEWG followed a similar process for both the Test & Evaluation and Production, Quality & Manufacturing career fields. The software competency framework allows the SATEWG to provide input to the expert panels of each career field that is consistent—as well as customized—to the needs of each career field.

The SATEWG has also started the process of identifying gaps in the existing software acquisition curricula. To conduct this analysis, the SATEWG uses the software competency framework, as well as the DAU's terminal and enabling learning objectives from their software acquisition management courses.

Table 1: *SATEWG Software Competency Framework Summary*

Knowledge Area	Competencies
1. Software Acquisition and Sustainment Planning: The activities used to plan for the acquisition, development, and sustainment of software across the life cycle.	1. Software Impact on Acquisition Strategy* 2. Software Planning* 3. Software in the Work Breakdown Structure 4. Integrated Master Plan/Integrated Master Schedule 5. Planning for Software Transition and Sustainment
2. Software Development Considerations: Software development is a process of defining and executing software solutions from system-level requirements, which have been allocated to software. This includes the life-cycle activities such as designing, developing, integrating, and testing of the software components of a system. It also includes design considerations such as compatibility, extensibility, fault-tolerance, maintainability, packaging, reliability, reusability, security, and usability, as well as the development of associated documentation.	6. Software Architecture* 7. Software Requirements* 8. Integration of Software and Systems Engineering* 9. Software Design* 10. Software Development Methodology 11. Software Integration* 12. Software Interface Management 13. Software Modeling and Simulation 14. Verification & Validation of Software 15. Software in Systems Engineering Plans 16. Software Interoperability* 17. Software Safety* 18. Software Security* 19. System and Software Engineering Environment 20. Software Trade Studies
3. Software Management: Establishes a common framework for software life-cycle processes, with well-defined terminology that applies to the acquisition of systems and software products and services, to the supply, development, operation, maintenance, and disposal of software products, and to the software portion of a system.	21. Software Configuration and Data Management 22. Software Risk Management* 23. Software Technical Reviews 24. Software Quality Assurance* 25. Software Financial Management and Estimation* 26. Software Contracting Considerations 27. Software Measures*
4. Post-Deployment Software Support: The planning, sustainment, and management activities related to the performance of preventative, predictive, scheduled, and unscheduled actions aimed at maintaining or improving software performance (e.g., functionality, efficiency, reliability, availability, maintainability, security, and safety).	28. Transition to Sustainment 29. Sustainment

Future Direction

While the SATEWG remains focused on the goals outlined by the original charter, members are identifying opportunities that go beyond it. These efforts further bridge the gap between current and desired software proficiency and also reach a new audience: software experts who are critical in managing the complexity of today's software-intensive systems. Such efforts include:

- Formally validating the framework.
- Fostering a learning environment and addressing the training needs of software experts.
- Establishing a government-wide occupational career code for software engineering.

The SATEWG will start pursuing these additional efforts when the elements of the original charter are met. Current goals and future efforts will require support and collaboration with software and human capital leaders across the DoD. The SATEWG will continue to apply a collaborative approach to ensure continued success.

The SATEWG welcomes the involvement of software and human capital leaders across the DoD. Please contact the author if you would like to receive more information about the SATEWG's efforts.

Conclusion

Several studies conducted recently have highlighted both the human capital and software-related issues facing the DoD. To address the growing concern regarding software complexity and the capacity of the acquisition workforce, the SATEWG has made strides to ensure that software-related skills are both embedded in competency models and fostered within existing curricula.

The efforts of the SATEWG have led to the development of a framework

which lists the critical software competencies that are cross-functional and can be customized for each career field in the DoD. The SATEWG also uses this framework to review existing courses to ensure that the acquisition workforce is being trained in the necessary areas of software.◆

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